1. On certain Muscles of Birds and their Value in Classification. Part II. By A. H. Garrod, B.A., Fellow of St. John's College, Cambridge, Prosector to the Society.

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(Plate XVII.)

The facts contained in the former part of this communication (P. Z. S. 1873, p. 626) being in an expanded form, it is not easy to appreciate their full significance at a glance, nor without considerable difficulty. To obviate this inconvenience I have constructed the following table, which is so arranged that by a very simple method, it is possible to tell without further reference which of the five muscles—the ambiens, the femoro-caudal, the accessory femoro-caudal, the semitendinosus, and the accessory semitendinosus—are present or absent. To obtain this result the names of the muscles themselves have been omitted, and single letters of the alphabet used in their stead.

The femoro-caudal is represented by	A
The accessory femoro-caudal	B
The semitendinosus	X
The accessory semitendinosus	Y

When these four muscles are present in a bird the formula A B. X Y expresses the fact; when any one is absent, that such is the case is indicated by the omission of the letter representing it. Thus the formula A. X Y indicates that the accessory femoro-caudal muscle only is absent; A B. X that the accessory semitendinosus is missing; A. X that the femoro-caudal and semitendinosus only are to be found; and A that the femoro-caudal alone is present. These formulæ may be termed myological formulæ. No bird is known in which all these four muscles are deficient.

In the accompanying diagram (Plate XVII.) all those birds which have the same myological formula are included together in one circle; and the circles are so placed in relation to one another that, if they were drawn on the surface of a sphere, there would be only a single operation of addition or subtraction necessary to move from any one to any of its immediate neighbours.

Of the four letters A, B, X, and Y the following are the sixteen possible combinations.

A B. X Y	A B	*B. X Y*	*X Y*
A B. X	*A. X*	*B. X*	X
A B. Y	A. Y	B. Y	Y
A. X Y	*A*	B	0

Those printed in *italics* are those which, if considered as myological formulæ on the nomenclature above given, have been found amongst birds; in other words, there are eight different

types of muscular arrangement in the thighs of birds, as far as the four muscles now under consideration are concerned.

Each of the circles in the diagram is divided into two halves by a vertical line, so that the names of all those birds which are found to possess the ambiens muscle may be distinguished from those in which it is absent. The birds in which the ambiens is present are placed in the left-hand semicircles; those in which it is absent are to be found in the right-hand semicircles.

A few examples may illustrate the method of employing this table. Taking the *Musophagidæ*, for instance, they being found in the circle A B. X Y evidently possess all the four muscles—the femoro-caudal, the accessory femoro-caudal, the semitendinosus, and the accessory semitendinosus; and being on the left side, have also the ambiens. The *Strigidæ* being on the right side of the circle with the formula A, possess only the femoro-caudal, the ambiens being also absent; and so on. Those birds whose names appear partly in both semicircles may or may not possess the ambiens muscle in their different genera.

Before going further it will be necessary to show what degree of constancy is, as a rule, to be expected in the myology of birds. Respecting this point my experience is that individuals of a species agree precisely in their muscular arrangement. Many specimens of a considerable number of species have passed through my hands, and I have frequently dissected them one after another in order to detect, if possible, any individual variations; such, however, have not been forthcoming. It is true that in a single specimen of *Œdicnemus grallarius* the ambiens, instead of crossing the knee, ended on the inner side of the ligamentum patellæ; however, the muscle, though imperfectly developed, was undoubtedly there. The only other instance of an unexpected and abnormal individual structure was the presence in a specimen of *Pomatorhinus temporalis*, on one side only, of an accessory femoro-caudal, which I have not once seen in any other of at least 100 passerine birds that I have examined.

From these observations it is evident that individuals of a species all agree in the arrangement of the muscles of the thigh at least—so much so that any peculiarity observed in a specimen dissected for the first time may be taken to be characteristic of the species itself.

The same remarks apply to the species of a genus. Of several genera I have had the opportunity of dissecting many species, seven of *Bubo*, six of *Ardea* and *Columba*, five of *Buceros*, *Francolinus* and *Ibis*, four of *Chrysotis*, *Brotogerys*, and *Geopelia*, three of a large number, and two of many more. In all these genera the myology of the species does not vary, and its constancy is sufficient to justify the suspicion that when there are muscular differences between the species of an accepted genus, it is because genera have been combined which ought to be kept distinct. Such is evidently the case with *Conurus*, in which genus those without the red tail differ from those possessing it (*Pyrrhura*), the ambiens muscle being present in the former and absent in the latter. There are also other anatomical differences between them. The genus *Conurus*, therefore, as at pre-

sent generally defined, is too extensive, and from it must be separated off the genus *Pyrrhura* of Bonaparte.

In *Euplocamus* there is an apparent slight exception to the uniformity in generic myology. In some species, as *E. erythrophthalmus*, *E. albocristatus*, and *E. horsfieldii*, the femoro-caudal is present, though very small indeed; in a specimen of *E. vieilloti*, however, it could not be found at all. This tendency to the entire disappearance of an almost obsolete muscle, however, can have but little weight in generalizations of the character under consideration.

Ascending to the next zoological grade, in the families of birds there may be myological differences, though in some, such as the Anatidæ, the Accipitres proper, the Strigidæ, and most of the smaller families, none have yet been found. The femoro-caudal is the muscle which seems to be the most susceptible of variation. Amongst the Cathartidæ it is present in *Cathartes* and absent in *Sarcorhamphus* and *Gyparchus*. Amongst the Gallinæ it is absent in *Pavo* and *Meleagris*, very small or absent as above mentioned in *Euplocamus*, and well developed in *Gallus* and *Argus*. The various genera of Columbæ and Psittaci may or may not possess the ambiens, as is the case with *Conurus* and *Pyrrhura* mentioned above. Amongst the Cuculidæ, the Ground-Cuckoos (*Centropus*, *Guira*, *Phœnicophaus*) differ from *Cuculus* and its allies in having the accessory femoro-caudal developed, whilst it is absent in the latter, their respective formulæ being A B. X Y and A. X Y. This peculiarity, when added to those in the pterylosis, justifies the division of the family into two subfamilies, which may be termed the *Centropodinæ* and the *Cuculinæ*. In the same way the *Pici* differ among themselves in possessing or being deficient of the accessory semitendinosus, *Picus* being one of the latter, whilst *Gecinus*, *Leuconerpes*, &c. are of the former.

It may be inferred from the above statements that in the families of birds, though there may be myological differences amongst the genera, these differences are never more considerable than such as consist of the absence of one muscle from the typical arrangement of the family, or, in other words, from the modification of one element of the typical formula. When, therefore, it is found that under any accepted arrangement there are subfamilies differing from one another by more than a single muscular peculiarity, there is reason to expect that these subfamilies would be further separated in a natural arrangement. The *Accipitres* furnish an example; the myological formulæ of its subdivisions are subjoined, + and − indicating the presence or absence of the ambiens muscle:—

Falconidæ A+
Vulturidæ A+
Cathartidæ A. X Y+ or X Y+
Strigidæ A−
Serpentariidæ B. X Y+.

This table makes it evident that the *Falconidæ* and *Vulturidæ* are widely separated from the *Cathartidæ* and the *Serpentariidæ*, and that it is perfectly impossible to unite in any intimate way these

two latter families with the two former, or with one another. In fact the *Accipitres*, as generally defined, are not a natural group at all; and the *Cathartidæ* are not the least more nearly related to the *Vulturidæ* than to the *Falconidæ*.

Respecting families it may therefore be said that myological peculiarities which do not involve more than a single structural change from the typical arrangement of the family are frequent, and that further differences indicate a more distinct relationship.

The various opinions held by different ornithologists as to the correct division of the Orders of the Class Aves are so numerous that they make it impossible in this stage of the inquiry to discuss the myological features which they present. An inspection of Plate XVII. is sufficient to show that the formula of a bird is not of direct value in estimating ordinal characters.

Looking at the whole subject from another point of view, it may now be asked, What does the arrangement in the muscles above described teach as to the major divisions of the Class Aves? The remainder of this communication will be an attempt to answer this question.

A mere glance at Plate XVII. is sufficient to show that the facts disclosed by a study of the myology of birds do not, without extraneous assistance, place the different families in their true relationship to one another. Because the same muscles are present in two families of birds, it cannot therefore be said that their kinship is extremely close, or the reverse; if such were the case we should have to put the *Ardeidæ* with the Passeres, and to separate the Auks from the Gulls, both of which results would be strongly in opposition to the teaching of osteology. It is therefore necessary to look around to find, if possible, myological characters which have some definite relations to equally well-marked pterylographic, visceral, or osteological peculiarities.

Before going further it will be necessary to clearly understand a principle which is of much assistance in working out the details of classification from a large number of unarranged facts. It is this: when any certain structure is found to exist in an unmodified form in several clearly separable members of any well-marked larger division of the Animal Kingdom, that structure must be considered typical of the division; in other words, that structure, or the potentiality for producing it, must have existed in the common ancestor of the division under consideration; and those of its members who are wanting in the particular structure are so because they have lost it in process of time, not because the others have separately acquired it; for the probability, if it were only a matter of probability, is very little that several distinct and different species should separately acquire a single identical structure; whilst it is infinitely more likely that several distinct species should all lose a common character. That all Mammalia should acquire branched horns is improbable; but that many which possess branched horns should have them broken off whilst rushing through a wood, whatever species they belong to, is much more to be expected.

Employing this argument with regard to the facts under discussion,

the ambiens muscle is present in many not closely related birds. It is found in genera so distant as *Struthio*, *Gallus*, *Musophaga*, *Cuculus*, *Anser*, *Aquila*, *Ciconia*, and *Thalassidroma*. This muscle must therefore be considered typical in birds; it, or the full potentiality for acquiring it in time, must have existed in the ancestral bird. Consequently those birds in which it is absent may be set down as having possessed the muscle in their ancestral form, as having lost it, and, what is more, as having lost all power ever to recover it—because the probability that exactly the same structure should be reproduced as the result of the influence of forces different from those by which it first originated, especially when acting on the body modified upon its previous condition, is infinitely little. I find no tendency to atavism in any structure once fully specialized. The modification of the tarso-metatarse of the Penguin cannot be included in the same category. The bird is hatched, as are others, with an incipient potentiality to develop separate metatarsals; a modification of its early nutrition, together with peculiarities in its habits of life, prevent the metatarsals from blending into a cylindrical bone; and so they take on a semi-ancestral form. Therefore, and nevertheless, the Penguin is no nearer the Reptilia than any other bird. It is a true bird, derived from the Avian ancestor only, which is the same thing as saying that it has no special Reptilian affinities, although its terrestrial and aquatic habits may have caused it to be acted on by forces somewhat similar, and therefore to appear, but only to appear, to have a somewhat similar conformation. The same argument applies to all the members of the class. The Ostrich and Tinamou are no nearer to reptiles than is the Sparrow or the Parrot; they are birds, and therefore they cannot be any thing else. However similar any individuals of two families which separated off two centuries ago and have never intermarried may be, no one thinks of claiming any nearer relationship for the similar individuals than for the other members of the families. Why then should it be said that some birds are Reptilian and others not? Reptiles and birds can never have interbred, therefore there can be no relationship between them.

To return to the subject. There are some families of birds, such as the *Columbæ* and the *Psittaci*, in which different genera vary in possessing or not having the ambiens muscle developed. Those in which it is absent must, from previous considerations, have lost it since the families differentiated off; and therefore those families may be classed with the others in which the ambiens is present. The *Columbæ* are further complicated in the same way with regard to the cæca of the intestine; some have cæca, others have not; they must evidently be classed with birds possessing cæca. And generally, if exceptions to a rule are found, when they are in the direction of the loss of any given structural peculiarity, such exceptions are not of much detriment to an argument if other conditions are favourable. But positive exceptions, such as the reappearance of a lost character in minor divisions in the major division of which it is supposed to be absent, are not to be allowed under any consideration whatever.

For nearly the last two years I have been on the watch for a

structural character or a combination of characters to turn up which would give clear indications of the most important divisions of the bird class. My search has, to my own mind, been fairly satisfactory in its results; for the classification at which I have arrived appears to have a practicability about it which is decidedly promising.

The oft-named ambiens muscle is, in my idea, the key to the whole. In some families it is present, in others absent. By combining all those in which it is found into one subclass, to be subsequently termed *Homalogonatæ* (typically kneed, because the ambiens runs in the tendon of the knee), and all those in which it is absent into a second, to be subsequently termed *Anomalogonatæ* (abnormally kneed), a primary division is the result which the following facts will in great measure justify. It may be stated at once, however, that there are a few undoubtedly homalogonatous birds in which the ambiens muscle is absent; there cannot be any anomalogonatous birds in which it is present.

The following table (Table I.) contains the names of the various most important divisions of the Class of Birds, arranged according as they are homalogonatous or anomalogonatous. Those homalogonatous divisions with an asterisk (*) against them do not possess the ambiens muscle in any of their genera; in those with a dagger (†) it is wanting in certain genera only.

Table I.

Class **AVES**.

Subclass HOMALOGONATÆ.

Order I. GALLIFORMES.

Cohort (α) Struthiones.

Family 1. Struthionidæ.

Subfamily 1. *Struthioninæ*.

„ 2. *Rheinæ*.

Family 2. Casuariidæ (*).

„ 3. Apterygidæ.

„ 4. Tinamidæ.

Cohort (β) Gallinaceæ.

Family 1. Palamedeidæ.

„ 2. Gallinæ.

„ 3. Rallidæ.

„ 4. Otididæ.

Subfamily 1. *Otidinæ*.

„ 2. *Phœnicopterinæ*.

Family 5. Musophagidæ.

„ 6. Cuculidæ.

Subfamily 1. *Centropodinæ*.

„ 2. *Cuculinæ*.

Cohort (γ) Psittaci (†).

Order II. ANSERIFORMES.

Cohort (α) Anseres.

Family 1. Anatidæ.

Family 2. Spheniscidæ.
„ 3. Colymbidæ.
„ 4. Podicipidæ (*).
Cohort (β) Nasutæ.
Family 1. Procellariidæ (†).
„ 2. Fulmaridæ.
Subfamily 1. *Fulmarinæ*.
„ 2. *Bulweriinæ*.

Order III. CICONIIFORMES.
Cohort (α) Pelargi.
„ (β) Cathartidæ.
„ (γ) Herodiones (*).
„ (δ) Steganopodes.
Family 1. Phaethontidæ.
„ 2. Pelecanidæ.
„ 3. Phalacrocoracidæ.
„ 4. Fregatidæ.
Cohort (ε) Accipitres.
Family 1. Falconidæ.
„ 2. Strigidæ (*).

Order IV. CHARADRIIFORMES.
Cohort (α) Columbæ (†).
Family 1. Columbidæ.
„ 2. Pteroclidæ.
„ (β) Limicolæ.
Family 1. Charadriidæ.
„ 2. Gruidæ.
„ 3. Laridæ.
„ 4. Alcidæ (*).

Subclass ANOMALOGONATÆ.
Order I. PICIFORMES.
Family 1. Picariæ.
Subfamily 1. *Picidæ*.
„ 2. *Ramphastidæ*.
„ 3. *Capitonidæ*.
Family 2. Upupidæ.
„ 3. Bucerotidæ.
„ 4. Alcedinidæ.

Order II. PASSERIFORMES.
Family 1. Passeres.
„ 2. Bucconidæ (†).
„ 3. Trogonidæ.
„ 4. Meropidæ.
„ 5. Galbulidæ.
„ 6. Caprimulgidæ.
„ 7. Steatornithidæ.
„ 8. Coraciidæ.
Subfamily 1. *Coraciinæ*.

Subfamily 2. *Momotinæ*.
,, 3. *Todinæ* (?).

Order III. CYPSELIFORMES.
Family Macrochires.
Subfamily 1. *Cypselinæ*.
,, 2. *Trochilinæ*.

There are peculiarities in the arrangement of the cæca of the intestine and of the tuft of feathers on the oil-gland which are correlatable with this presence or absence of the ambiens muscle. Some birds possess cæca to the intestine at the same time that the oil-gland is tufted (1); others have cæca and a nude oil-gland (2), others a tufted oil-gland and no cæca (3), whilst a few have no cæca and a nude oil-gland (4); the genera *Didunculus*, *Goura* and *Treron* amongst the *Columbæ*, have no cæca and no oil-gland, wherein they differ from all other birds. Now it is a curious fact that it is only amongst the homalogonatous birds that the first of the above-named conditions is found, namely a tufted oil-gland combined with cæca to the intestine; and what is more, they nearly all agree with it. The following table (II.) contains the names of those birds in which a tufted oil-gland is combined with cæca to the intestine, an asterisk indicating the families in which there are certain exceptions.

Table II.

Struthiones *.	*Gruidæ*.
Crypturi.	*Anatidæ*.
Gallinæ *.	*Spheniscidæ*.
Otidæ *.	*Colymbidæ*.
Phœnicopteridæ.	*Procellariidæ* *.
Palamedeidæ.	*Ciconiidæ*.
Rallidæ.	*Ardeidæ* (one cæcum).
Limicolæ.	*Steganopodes*.
Laridæ.	*Falconidæ*.
Alcidæ.	*Vulturidæ*.

Respecting the exceptions, it may be mentioned that the *Struthiones* and *Otis* have no oil-gland; but as in their nearest allies it is tufted, they may be included amongst those in which it is so also. Amongst the *Gallinæ* I have always found the oil-gland nude in the *Megapodidæ* (*Talegalla* and *Megacephalon*). The Storm-Petrels have no cæca, and the *Ardeidæ* have only one.

It is therefore evident that from the whole list of birds termed homalogonatous, only the *Musophagidæ*, *Psittaci*, *Columbæ*, *Cuculidæ*, and *Cathartidæ* are exceptions to the above-stated rule, the first two having no cæca, the next two a nude oil-gland, and the last neither cæca nor a tufted oil-gland.

Another myological fact comes in here to assist. A reference to Plate XVII. in comparison with Table I. will show that no anomalogonatous bird has been found to possess the accessory femoro-caudal; that is, B never enters into its myological formula. Such being the case, when a bird has a formula with B in it, at the same time that

either the ambiens muscle is absent, or has a nude oil-gland in combination with intestinal cæca, it is certain to be a homalogonatous bird. That the formula of the *Musophagidæ* is A B. X Y, and the ambiens is present, therefore more than counterbalance the exception presented by the arrangement of their cæca and oil-glands. The same remarks apply to the *Cuculidæ*. The *Cathartidæ* possess the ambiens, which, in conjunction with many other Ciconiine characters, leaves no doubt about their position; and the *Psittaci* cannot, from the presence of an ambiens in some of them, be placed with the Anomalogonati, to which they otherwise present many points of similarity.

Excluding the *Macrochires*, which have a nude oil-gland and no cæca, all the other anomalogonatous birds have either a nude oil-gland and cæca, or a tufted oil-gland and no cæca; and this definite set of features makes it easy to divide them up into two main orders, the Piciformes and the Passeriformes.

Piciformes, with tufted oil-gland and no cæca.	Passeriformes, with nude oil-gland and cæca.
Pici.	*Passeres.*
Capitonidæ.	*Bucconidæ* (?).
Ramphastidæ.	*Trogonidæ.*
Upupidæ.	*Meropidæ.*
Bucerotidæ.	*Caprimulgidæ.*
Alcedinidæ.	*Steatornithidæ.*
	Coraciidæ.
	Momotidæ.

The position of the Macrochires is uncertain. In so far as the mouth tends to get very broad it resembles some of the Passeriformes.

As before remarked, none of the Anomalogonatæ possess the accessory femoro-caudal muscle. In them also the posterior margin of the sternum is more perfectly formed than in the Homalogonatæ. Scansorial feet are found in both divisions; but whilst those of the Parrots and Cuckoos exhibit a similar arrangement of the tendons of the toes, the Toucans, Woodpeckers, and Jacamars follow a quite different type.

All the birds which present the palatal characters expressed by Prof. Huxley's term Schizognathous, and the nasal characters expressed by my term Schizorhinal, are homalogonatous. All non-struthious birds with a truncated vomer are anomalogonatous.

As to what appear to me to be the main divisions of the homalogonatous birds, the myology of the thigh does not give more than a certain amount of assistance. In list I. it will be seen that large brackets precede the names of the smaller divisions or families, separating them into what to me are worthy of the dignity of orders. From these it is evident that I would divide homologonatous birds into four orders, I. Galliformes, II. Anseriformes, III. Ciconiiformes, and IV. Charadriiformes (Schizorhinæ). These must be considered separately.

The Galliformes include all the birds in which there is any approach in structure to the common Fowl. With the exception of

the *Psittaci* (which in other points also are peculiar), and the *Cuculinæ* from amongst the Cuculidæ, they all possess the accessory femoro-caudal (B) well developed. The semitendinosus (X) and the accessory semitendinosus (Y) are always present, and, except in *Casuarius*, *Dromæus*, and some *Psittaci*, the ambiens is to be found well developed.

The presence of both the accessory femoro-caudal and the accessory semitendinosus (that is, of both B and Y in their myological formula) is the most characteristic feature which they have in common, giving the formula B. X Y as typical.

The Anseriformes include most of the web-footed birds. Their most marked characteristic is the presence of the accessory femoro-caudal (except in *Bulweria*), whilst the accessory semitendinosus is absent, except in the Storm-petrels. With the exception of the *Podicipidæ*, the femoro-caudal is present; so that their formula is nearly always A B. X. Excluding *Podiceps* and a Storm-petrel in the case of one specimen examined, I have always found the ambiens present.

The Ciconiiformes are less easily defined than the other groups. The cæca coli are never long; the accessory femoro-caudal is never present; and the obturator externus is frequently more developed than in other birds, to replace it in action. It is in the pectoral region that these birds most closely agree. The strong short anterior costo-coracoid ligament, the bowed space between the superior margin of the second pectoral muscle and the furcula, and the frequently complicated arrangement of the great pectoral, whereby it is developed in a superficial and a deep layer (in which, by the way, the *Procellariidæ* agree with them), all point to a not far distant relationship. The *Ardeidæ* are the most aberrant of the order, the ambiens muscle being always absent in them at the same time that there is only one colic cæcum.

The Charadriiformes correspond to the Schizorhinæ, so named by me on account of a peculiarity in the structure of the nasal bones, which is sufficiently special in my estimation to justify the separation of all those birds in which it is found into a single order by themselves. There are considerable myological differences amongst its families according to their habits, the only uniform character being the presence of the femoro-caudal muscle. The ambiens is absent in the *Alcidæ* (*Alca*, *Uria*) and some *Columbæ*.

The minor divisions of the orders above defined must now engage our attention.

The order Galliformes may be divided into three main divisions or cohorts—α. the *Struthiones*, β. the *Gallinaceæ*, and γ. the *Psittaci*.

α. The *Struthiones* are peculiar in the structure of the palate; and in them the sciatic nerve and artery always perforate the fibres of the accessory femoro-caudal in a manner not found in any other birds.

They are divisible into four families, the first three of which have no oil-gland:—

1. *Struthio* and *Rhea*, which form each the type of a separate subfamily. In common they have the formula B. X Y, the ambiens muscle present, and long sacculated cæca coli, which in *Struthio* are

situated peculiarly far from the cloaca. There is no aftershaft to the contour feathers. *Struthio* has two carotids, *Rhea* only the left.

2. The genera *Casuarius* and *Dromæus*. They have the formula A B. X Y and B. X Y respectively. The ambiens muscle is absent, the cæca coli are short, and there is a very large aftershaft to the contour feathers. There are two carotid arteries.

3. *Apteryx*, in which there is an extra femoro-caudal muscle, the formula otherwise being A B. X Y. The ambiens is large; the cæca coli are well developed; and there is only one carotid, the left.

4. The *Crypturi*, with a formula A B. X Y. The ambiens muscle is large; the cæca coli are well developed; and an oil-gland is present, well tufted. The aftershaft may or may not be present on the contour feathers.

β. The *Gallinaceæ* all comprise B. X Y in their formula; the ambiens is present in all; and except in the *Musophagidæ* there are always cæca to the intestine.

They are divisible into six families:—

1. The *Palamedeidæ*, with formula A B. X Y, the ambiens present, cæca sacculated as in *Struthio* and *Rhea* only, two carotid arteries, no aftershaft or a very small one, and a tufted oil-gland.

2. The *Gallinæ*, with formula A B. X Y or B. X Y. The ambiens is always present, as are cæca coli, an aftershaft, and a third pectoral muscle beneath the second; the oil-gland may be strongly tufted, or the tuft may be very weak; in the *Megapodidæ* it does not exist. The second pectoral is very long; and there is a characteristic shape about the sternum. In the *Megapodidæ* there is only one carotid, the left; in all the others both are present. Neither *Turnix* nor *Pterocles* are included in this family.

3. The *Rallidæ*, with formula A B. X Y, the ambiens and cæca present, two carotids, an aftershaft, a tufted oil-gland, and a characteristic sternum. *Parra* is not included.

4. The *Otididæ*, including the *Otidinæ*, *Œdicnemus*, *Serpentarius*, and *Cariama* (and perhaps the next genus, *Phœnicopterus*). The formula is B. X Y; the ambiens and cæca are present, as is the aftershaft; there are generally two carotids, though in *Otis denhami* the right only is present, and in *Tetrax* the left; the oil-gland when present, as in all but *Otis*, is tufted, except in *Cariama* and *Chunga*.

5. The *Musophagidæ*, with formula A B. X Y, an ambiens muscle, two carotids, an aftershaft, a tufted oil-gland, and no cæca.

6. The *Cuculidæ*, with an ambiens muscle, two carotids, nude oil-gland, and cæca. They form two subfamilies:—

The *Centropodinæ*, or Ground-Cuckoos, with formula A B. X Y.

The *Cuculinæ*, or true Cuckoos, with formula A. X Y.

γ. The cohort *Psittaci* presents in many points intermediate characters between the homalogonatous and the anomalogonatous birds. With a constant formula A. X Y, no cæca or gall-bladder, an oil-gland tufted or absent, the ambiens may or may not be present, and the carotids may exhibit peculiarities in their arrangement*.

The order Anseriformes may be divided into two cohorts—*α*. the *Anseres*, *β*. the *Nusutæ*.

* See P. Z. S. 1873, p. 465.

α. The *Anseres* include four families, (1) the *Anatidæ*, (2) the *Spheniscidæ*, (3) the *Colymbidæ*, and (4) the *Podicipidæ*. With the exception of the Podicipidæ, they agree in having a formula A B. X, an ambiens muscle, cæca to the intestine (except *Mergellus*, in which there is only one small cæcum), two carotids, a very elongate great pectoral muscle, which meets its fellow of the opposite side above the symphysis furculæ in a median raphe, and a tufted oil-gland. The *Podicipidæ* have for formula B. X; the ambiens is absent, as is frequently the semimembranosus; the left carotid only is present; there are cæca coli and a tufted oil-gland.

β. The *Nasutæ*, including the Storm- and true Petrels. I have not dissected *Diomedea*. They are divisible into two subfamilies :—

1. The Storm-petrels, with formula A B. X Y, no cæca, a tufted oil-gland and a peculiar sternum. The ambiens does not seem to be always developed. The great pectoral is double.

2. The *Fulmaridæ*, with formula A B. X, the ambiens muscle present, two short cæca, a tufted oil-gland, and a characteristic sternum. *Bulweria* is exceptional in having its formula A. X, and therefore quite different from that of the Storm-Petrels. The great pectoral is double.

The order Ciconiiformes may be divided into five cohorts of somewhat different importance :—

1. The *Pelargi*, with formula A. X Y, an ambiens muscle, a tufted oil-gland, intestinal cæca, and a double great pectoral muscle.

2. The *Cathartidæ*, with formula A. X Y, an ambiens muscle, no cæca, a nude oil-gland, and a double great pectoral muscle.

3. The *Herodiones*, with formula A. X Y or X Y, no ambiens muscle, a single cæcum coli, and a tufted oil-gland.

4. The *Steganopodes*, which do not form so natural a family, in my eyes, as in those of many ; for their myological formula is not the same in all, being

In *Phaethon* A. X Y,
In *Sula* and *Phalacrocorax* A. X,
In *Fregata* A,

from which it may be inferred that *Phaethon* approaches the Ciconiidæ and *Fregata* the Accipitres. They all possess the ambiens, cæca, a tufted oil-gland, and the four toes included in a web, which is but imperfectly developed in some. *Sula* and *Phalacrocorax*, with *Plotus*, form one family, *Phaethon* another, *Fregata* a third, and *Pelecanus* a fourth.

5. The *Accipitres* proper include the Falconidæ and the true Vultures (between which there is not even any subfamily structural difference), together with the Strigidæ. Their formula is A; the ambiens is present (except in the Strigidæ), as are cæca, a tuft to the oil-gland, and an aftershaft (except in *Pandion*).

The order Charadriiformes, including all the Schizorhinal birds, is a large one, and may be divided into two cohorts—*α*. the *Columbæ*, and *β*. the *Limicolæ*. They all, except *Arctica alle*, have two carotids.

α. The *Columbæ*, including the *Pteroclidæ*, have a formula A B. X Y (except in *Lopholæmus*, in which it is apparently A. X Y). The ambiens muscle is sometimes present, sometimes absent. The oil-gland, if present, is nude; cæca may or may not be present; and the pterylosis is a very diffused one.

β. The *Limicolæ* have a tufted oil-gland and cæca; they form four families at least:—

1. The *Charadriidæ*, with formula A B. X Y and A. X Y, and an ambiens muscle.
2. The *Laridæ*, with A. X Y formula, and an ambiens muscle.
3. The *Gruidæ*, with formula A B. X Y, and an ambiens muscle.
4. The *Alcidæ*, with formula A B. X, and no ambiens muscle.

The Anomalogonatous birds form three cohorts—α. the *Passeriformes*, β. the *Piciformes*, and γ. the *Cypseliformes*. They are divisible into the following families:—

α. *Passeriformes*.

1. The *Passeres*, with a formula A. X Y (except in *Dicrurus*, in which it is A. X), a characteristic palate and sternum (except in *Pteroptochus*), a left carotid only, and a characteristic *tensor patagii brevis* muscle (to be described on a future occasion).
2. The *Bucconidæ*, of which I have not dissected any example, but which most probably come here.
3. The *Trogonidæ*, with formula A. X, a left carotid only, and a very passerine pterylosis.
4. The *Meropidæ*, with a formula A. X Y, and a left carotid only.
5. The *Caprimulgidæ*, with a formula A. X Y, and two carotids.
6. The *Steatornithidæ*, with a formula X Y, and two carotids.
7. The *Coraciidæ*, in which the *Coraciinæ* and *Momotinæ* are combined, on account of their not presenting family differences. They have a formula A. X Y, and two carotids.
8. The *Galbulidæ*, with a formula A. X Y or A. X, two carotid arteries, and a scansorial foot.

β. *Piciformes*.

1. The *Picariæ*, to include the *Pici*, the *Ramphastidæ*, and *Capitonidæ*, these three not in any point presenting family differences. They may be divided into two subfamilies, the *Pici* forming the one, the *Ramphastidæ* together with the *Capitonidæ* forming another. The formula is A. X Y (except in the *Picinæ* among the *Pici*); the form of the sternum and of the tensor patagii brevis is characteristic. The foot is scansorial.
2. The *Upupidæ*, with formula A. X Y, a characteristic pterylosis, a left carotid only, and a passeriform foot.
3. The *Bucerotidæ*, with formula A. X Y, no fat found on the body, a characteristic sternum, and one or two carotids.
4. The *Alcedinidæ*, with formula A. X, and two carotids.

γ. *Cypseliformes*, including the *Cypselidæ* and *Trochilidæ*, between which the differences are only of subfamily importance. The formula is A; the tensor patagii brevis and the pterylosis are characteristic, as is the sternum; and there is only a left carotid (except in *Cypseloïdes*).